

# FLORAL MICROCHARACTERS AND TAXONOMY OF THE *CYANTHILLIUM CINEREUM* COMPLEX (ASTERACEAE: VERNONIEAE)

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## Abstract

In this study of *Cyanthillium cinereum* (L.) H. Robinson four varieties are recognized, one of which is new and three are new combinations. The floral microcharacters of the species and its varieties are described.

## Introduction

The genus *Cyanthillium* Blume was resurrected by Robinson (1990) who transferred *Vernonia cinerea* (L.) Less., *V. stellulifera* (Benth.) C. Jeffrey and *Conyza patula* Ait. to the genus. The transfer was based on the pollen characteristics, which are remarkably different from those of the genus *Vernonia* and other Vernonieae in that the colpus is not evident and the grains have a polar areole surrounded by a tier of five to seven areoles. In other words the polar organization is basically different from most forms in the tribe which have well developed colpi. According to Robinson (1990) the genus *Cyanthillium* is distinctive within the non-colporate genera of the Old World by the modification of the basal columellae of the exine to form bridges under the crests.

However, the genus is substantially different from the genus *Baccharoides* Moench, which possesses grains with long colpi (Isawumi & El-Ghazaly in press). The pollen study of *V. cinerea* by Kingham (1976) also pointed out the lack of colpi in the species.

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## Materials and Methods

The material for this study was obtained from the herbarium of the Swedish Museum of Natural History in Stockholm (S). For the micro morphological observations, florets were softened in boiling water to which a drop of detergent was added, dissected under a stereo microscope, mounted in Hoyer's solution (Anderson 1954, King & Robinson 1970) and studied with LM.

## Results and Discussion

### MORPHOLOGICAL MICROCHARACTERS

#### Corolla pubescence

Pubescence of the corolla lobes is a common feature in the Asteraceae. Uniseriate eglandular trichomes and capitate glands are commonly found on the corolla lobe tips of *Cyanthillium cinereum* and its varieties in all the geographical areas where they occur (Fig. 1A), except var. *ugandense*, which has unicellular eglandular trichomes and T-shaped trichomes in addition (Fig. 2E). On the corolla lobe tips of the varieties in Madagascar are found uniseriate and biseriate stalked glands in addition to the ones mentioned above. In all the varieties, the same types of trichomes found on the corolla lobe tips are present on the limbs and tubes with sometimes slight modifications.

The uniseriate eglandular trichomes are different from those found in the genus *Baccharoides* (Isawumi & El-Ghazaly in press) because they are usually very long, about 2–3 cells long, with the apical cells much longer than the others. These trichomes are also different from those present on the corolla lobes of *Vernonia s.l.* This character can be conveniently used to separate the varieties occurring in Uganda and Madagascar.

#### Anther apical appendage

The anther apical appendages are sufficiently different within the species to bring about the delimitation of the varieties. In the varieties that occur in Australia, Tanganyika, Zimbabwe (S. Rhodesia) and Malawi, the apical appendages are distinctly ovate and obtuse at tips (Fig. 2H). Some varieties which occur in Uganda, Jamaica, Trinidad (West Indies), and Philippines, have apical appendages that are slightly dilated proximally, taper towards the apex and are obtuse or sometimes acute at tips (Fig. 3I).

In Madagascar there are two types of apical appendages. In var. *viale*, the appendage is more or less lanceolate or ovate-lanceolate and obtuse at tip (Fig. 3J), while in var. *ovatum* it is ovate with truncate tip which is slightly notched in the middle (Fig. 3K).

The anther apical appendages are not conspicuously constricted at the base as normally in the tribe Vernonieae (sensu King & Robinson 1970) but they are as wide as the thecae (cf. Anderberg 1991). Furthermore the appendages do not have glands like the neotropical Vernonieae (Robinson & Kahn 1986).

### Endothelial tissue

The endothelial tissue in the species and its varieties is intermediate (Fig. 1B) with the cells thickened on both the horizontal and radial walls (Dormer 1962, Nordenstam 1978). The thickenings are weakly connected across the external surface of the cells (Fig. 1B) as usually found in the tribe Vernonieae (Robinson 1977). This character is autapomorphic for the tribe Vernonieae.

The endothelial tissue in the genus *Baccharoides* is distinctly polarized (Isawumi & El-Ghazaly in press) and therefore different from the one in this species which is placed in the resurrected genus *Cyanthillium*.

### Filament collars

The filament collars have long been used by synantherologists for taxonomic discrimination (Nordenstam 1978). The collars are the uppermost parts of the filaments. They are narrowly cylindrical, elongate, straight and not wider than the filaments (Fig. 2G) in all the varieties of this species. They are different from those found in the genus *Baccharoides* which are ovate and sometimes dilated distally (Isawumi & El-Ghazaly in press).

The filaments in this species are inserted on the corolla at the limb/tube junction.

### Base of anther thecae

The terminology to describe the basal portion of the anthers, suggested by Robinson (1983), viz., calcarate (spurred) versus ecalcarate, has been used in synantherology by many authors (Bremer 1987, Anderberg 1991, Karis 1993). The anthers in *Cyanthillium cinereum* are long calcarate because the thecae extend below the point where the filament connects with the anther (Fig. 2G).

### Ovary wall crystals

Ovary crystals have been used successfully in the taxonomic evaluation of several tribes of the family Asteraceae (Dormer 1961, Nordenstam 1978, Nordenstam & El-Ghazaly 1977, Anderberg 1991). Crystals are usually absent in tribes with carbonized achene walls (Robinson 1977).

In *C. cinereum* the ovary wall crystals are narrowly elongate och hexagonal in surface view and rectangular in side view (Fig. 2F).

Crystals sometimes found in the corolla and style may have various shapes - spindle-shaped, hexagonal, clustered, lozenge.

### Style base

The style base is conspicuously ring-like with the cells well thickened with simple pits (Fig. 1D). The cells are more or less rectangular and range from 1–5 in a row. The ring-like style base is absent in the genus *Baccharoides*, which has the style base completely covered by the nectary (Isawumi 1993).

### Cypsela

The term cypsela (sensu Stearn 1966, Fahn 1982) is often considered more strictly correct than the term achene (sensu Wagenitz 1976). The cypsela of *C. cinereum* is subfusiform, terete, more or less ribbed, and narrowed below.

The pubescence of the cypselas in the varieties shows some slight variations. The cypselas may have many idioblasts, few capitate glands and many twin hairs whose parallel cells fuse almost to their apices (Fig. 1C). In the varieties occurring in Zimbabwe, Uganda, Malawi, and Madagascar, one of the parallel cells is longer than the other cell. The parallel cells in the varieties in Trinidad, Madagascar (i.e. var. *ovatum*), British Guiana, and Tanganyika are almost of equal length (Fig. 1C). The cypsela trichomes have been called twin hairs (Hess 1938), but they usually have three cells (Nordenstam 1968, Bremer 1987, Anderberg 1991), one basal-lateral and two elongated parallel cells. At the point of fusion of the two parallel cells are sometimes found simple pits (Fig. 1C).

### Testa epidermis

Testa epidermis in *C. cinereum* and its varieties is ornamented with pattern rather different from that of *Baccharoides* (Isawumi & El-Ghazaly in press).

### Carpopodium

The carpopodium of the species and its varieties has cells which are heavily thickened with pits like in the genus *Baccharoides*.

## Pappus

The species has an outer pappus of distinct, short, linear, fimbriate scales. The inner pappus bristles are white, terete and readily caducous. Sometimes the outer pappus scales may be absent.

The pappus has been a classical source of information at the generic level but less so at higher levels (Bremer 1987), and much emphasis has been given to this structure in the classification of *Vernonia s.l.* (Jeffrey 1988, Wild 1978, Pope 1992, Isawumi 1989, 1993).

## TAXONOMY

*Cyanthillium cinereum* (L.) H. Robinson, in Proc. Biol. Soc. Wash. 103: 252 (1990).

*Conyza cinerea* L., Sp. Pl. 2: 862 (1753).

*Vernonia cinerea* (L.) Less. in Linnaea 4: 291 (1829); DC., Prodr. 5: 24 (1836); Oliv. & Hiern in F.T.A. 3: 275 (1877); Eyles in Trans. Roy. Soc. S. Afr. 5: 503 (1916); Mendonca, Contrib. Conhec. Fl. Angol., 1 Compositae: 14 (1943); Adams in F.W.T.A. ed. 2, 2: 283 (1963); Wild in Kirkia 11: 80 (1978); Maquet in Fl. Rwanda, Spermat. 3: 558 (1985); C. Jeffrey in Kew Bull. 43: 224 (1988); G.V. Pope in Fl. Zambesiaca 6: 143 (1992); H. Humbert in Fl. Madagascar 1: 18 (1960); Fawcett and Rendle in Fl. Jamaica 7 (5): 162 (1936); Cheeseman, Hill & Burt in Fl. Trinidad and Tobago: 58 (1940); Bentham in Fl. Australiensis 3: 459 (1866, reprint 1967). Type: Sri Lanka, Hermann (Lectotype BM, Herb. Hermann, vol. 3).

### (i). var. *cinereum*

*Vernonia cinerea* (L.) Less. subsp. *cinerea*, H. Humbert in Fl. Madagascar, Composées 1: 19 (1960).

Phyllaries 3-seriate, outer linear, inner lanceolate, c. 4 mm long; cypsela c. 1.5 mm long; outer pappus scale-like, slightly persistent; inner ones terete, barbellate, white, c. 3.5 mm long.

Distribution: This variety is pantropical. Madagascar, Majunga, Viguier et Humbert s.n. (S), cited by Humbert (1960); Decary 10592 (S); also in Kenya, Tanzania. A specimen without locality in P (Humblot s.n.) also belongs here. Humblot collected in Madagascar and the Comoro Islands.

### (ii). var. *ugandense* (C. Jeffrey) Isawumi comb. nov.

Basionym: *Vernonia cinerea* (L.) Less. var. *ugandensis* C. Jeffrey, in Kew Bull. 43: 224 (1988); G.V. Pope in Fl. Zambesiaca 6: 143 (1992). Type: Uganda, West Nile Dist. Terego, Hasel 492 (K holotype).

Corolla lobe tip with unicellular and T-shaped eglandular trichomes and many capitate and long stalked uniseriate glands. Anther apical appendage lanceolate-ovate and

obtuse at tip; filament collar straight, elongate, with the cells much thickened on the horizontal walls. Cypsela 5-costate, 1.5–1.8 mm long, sparsely pilose with twin hairs having parallel cells of unequal length; inner pappus bristles c. 3 mm long.

Taxonomic note: This variety, according to Jeffrey (1988) and Pope (1992) can be distinguished by its shorter inner pappus. It has other distinguishing characteristics which include the presence of T-shaped trichomes on the corolla lobe tip (Fig. 2E). This character is found only in this variety.

Distribution: Uganda, Ruwenzori, Kilembe, alt. c. 1,200–1,500 m, Taylor 2464 (S); also in Kenya.

(iii). var. *viale* (DC.) Isawumi, comb.nov.

Basionym: *Vernonia vialis* DC., Prodr, 5: 25 (1836). - *V. cinerea* (L.) Less. subsp. *vialis* (DC.) H. Humbert in Fl. Madagascar, Composées 1: 20 (1960). Type: Madagascar, Tamatave, Bojer s.n. (BM). Syn. *V. arguta* Bak. in J. Linn. Soc. 20:175 (1883).

Corolla lobe tip with few unicellular eglandular trichomes (like twin hairs), many long uniseriate eglandular trichomes and capitate glands; outer phyllaries linearfiliform, inter phyllaries lanceolate, acuminate/apiculate, 6 mm long. Anther apical appendage lanceolate-ovate and obtuse at tip. Crystals in the style tiny and spindle-shaped. Cypsela c. 1 mm long; inner pappus bristles c. 5 mm long.

Taxonomic note: This variety has been found only in Madagascar. Its anther apical appendage is long, lanceolate-ovate (Fig. 3J). It also has many spindle-shaped crystals in the style.

Specimen examined: Madagascar, Firingalava, Perrier 597 (S), cited by Humbert (1960).

(iv). var. *ovatum* Isawumi, var. nov.

Holotype: "Lecta in Madagascar a D. Thunberg", ex herb. Swartz (S).

Herba annua erecta. Folia lanceolata, petiolata, margine serrata; supra pilosa, infra dense pilosa. Receptaculum convexum epaleatum. Phyllaria 3-seriata, dense pilosa; externis linearibus, intimis linearibus-lanceolatis 5 mm. longis, acuminatis apiculatis. Corolla 3.5–5 mm. longa. Antherae basi calcaratae; appendicibus apicalibus ovatis truncatis leviter incisuris. Filamentum collum rectum elongatum. Cypselae 1 mm. longae, 5-costatae, sparsim pilosae. Pappi setae interiores c. 4 mm. longae, barbellatae, albae, caducae.

An erect annual herb. Stems branching above, longitudinally ribbed, densely pilose. Leaves lanceolate, petiolate, with serrate margins, pilose above, densely pilose beneath. Receptacle convex, epaleate. Phyllaries c. 3-seriate, densely pilose with very long hairs; outer ones linear, inner ones linear-lanceolate, c. 5 mm long, acuminate-apiculate at tips. Corolla 3.5–5 mm long, very narrowly funnel-shaped; corolla lobe tip with many uniseriate and biseriate stalked glands. Filament collar straight, elongate



with the cells rectangular and uniformly thickened. Anthers calcarate; anther apical appendage ovate with more or less truncate tip, slightly notched in the middle; some of the hairs on the style branches and upper part of shaft short and obtuse at tip; endothecial tissue intermediate with thickenings on both the horizontal and radial walls. Cypselas 1 mm long, 5-costate, turbinate, sparsely pilose with twin hairs having parallel cells of unequal length, few capitate glands and few idioblasts. Pappus without outer scales, inner ones c. 4 mm long, barbellate, white, terete, caducous.

**Taxonomic note:** This variety is different from the other ones because it has anther apical appendage which is ovate with truncate tip slightly notched in the middle (Fig. 3K). The varietal epithet refers to the distinct ovate shape of the apical appendage.

**Distribution:** It occurs probably only in Madagascar, if the location is correct. Swartz' annotation on the back of the type, "lecta in Madagascar a D. Thunberg" is obviously incorrect, since Thunberg never visited Madagascar.

### **Taxonomic notes on geographically separated populations of *C. cinereum* var. *cinereum***

#### (a) Tanganyika

Stem branches are densely pilose with long hairs intermingled with long uniseriate ones clustered at nodes and up to 20 cells long. Cypselas are 1.8–2 mm long, densely appressed pilose with twin hairs whose parallel cells are almost equal in length and with acute tips. Pappus with outer scales slightly broader than the inner ones which are terete, barbellate, white, c. 4 mm long, and readily caducous.

Specimen examined: Tanganyika, Pangani, Misubugwe forest, Tanner 2190 (S).

#### (b) Malawi

The variety in Malawi is differing slightly from the one in Tanganyika by lacking outer pappus scales, and the twin hairs on the cypselas have parallel cells which are of unequal length. These are minor variations which cannot be used to create a new variety.

Specimen examined: Malawi, Zomba Dist, Makoka Agric. Resea, Balaka & Usi 1514 (S).

#### (c) Trinidad

The twin hairs on the cypselas are similar to the ones in the variety in Tanganyika but different from those found in Malawi because their parallel cells are almost of equal length (Fig. 1C). The anther apical appendage is ovate, much dilated proximally and tapering to the apex and obtuse/acute at tip.

Specimen examined: Trinidad, Broadway 7947 (S).

## (d) The Philippines

This population is similar to the one in Tanganyika.

Specimen examined: Philippines, Ramos & Edano 43993 (S).

## (e) Jamaica

The variety in Jamaica is similar to the ones in the Philippines and Tanganyika in all respects.

Specimen examined: Jamaica, Yunker 17890 (S).

## (f) British Guiana

Specimen examined: British Guiana, Georgetown, Hitchcock 16595 (S).

## (g) Zimbabwe

The variety in this area is similar to the ones above except that it has no outer pappus and the twin hairs on cypsela have parallel cells which are of slightly unequal length and are acute/obtuse at tips. The cypselas are terete without ribs.

Specimen examined: Zimbabwe (S. Rhodesia), Royen 13461 (S).

## (h) Australia

The Australian population is similar to the ones in the Philippines, Jamaica and Tanganyika.

Specimen examined: Australia, Eriksson 402 (S).

## (i) India

The population is similar to the one in Zimbabwe with respect to the cypsela which is not ribbed; its cypsela is c. 2 mm long.

Specimen examined: India, Madras, Keebola' 8197 (S).

## (j) China

The specimen seen is similar to the ones from India, Philippines, etc. Its cypsela is densely pilose, c. 0.6 mm long; inner pappus bristles terete, white, c. 4.5 mm long and readily caducous.

Specimen examined: China, Wulsin *et al.* 12481 (S).

### Conclusion

The species and its varieties are rightly transferred from *Vernonia s.l.* to the resurrected genus *Cyanthillium* because of its distinct pollen characteristics and floral microcharacters. Its pollen has no colpus in contrast to the genus *Baccharoides* (Isawumi & El-Ghazaly in press) and the genus *Vernonia s.l.* The endothelial tissue is



intermediate unlike the one in *Baccharoides* which is distinctly polarized (Isawumi & El-Ghazaly in press). The filament collar is elongate and straight unlike the ones in *Baccharoides* which are more or less shortly cylindrical and sometimes somewhat dilated distally.

There are about three varieties in East Africa and three also in Madagascar. The var. *lenti* (O. Hoffm.) C. Jeffrey reported by Jeffrey (1988) as occurring in Kenya and Tanzania could not be included in this work. The area of greater diversity of the species is therefore probably in East Africa and Madagascar. It is suggested that the species might have originated either in East Africa or Madagascar and spread by introduction to other parts of tropical areas of the World.

Hitherto the varieties have been delimited on the bases of the size of inner phyllaries, cypselas and inner pappus bristles (Jeffrey 1988, Pope 1992). It is found in this study that the microcharacters are strongly diagnostic for the varieties and can be easily used along with other characters for their separation and identification.

The species is pantropical and found in tropical Asia, India, China, Philippines, Australia, Jamaica, West Indies, South America, and Madagascar. On the African continent it is known from Zimbabwe, Malawi, Mozambique, Zaire, Rwanda, Uganda, Kenya, Tanzania, Tanganyika, Angola, and other parts of Southern Africa, and also in tropical West Africa. It thus occurs throughout the paleotropical region and is widely adventive in the neotropics (Robinson 1990).

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## FIGURE LEGENDS

- Fig. 1 A: *Cyanthillium cinereum* var. *cinereum* in Trinidad - Corolla lobe tip with eglandular trichomes 2-3 cells long and capitate glands, x 230;
- B: Endothecial tissue intermediate with both horizontal and radial walls thickened, x 325;
- C: Twin hairs with parallel cells almost of equal length, fused almost to the apices and with simple pits at the fused areas; idioblasts on cypselas. x 230; Broadway 7947 (S).
- D: *C. cinereum* var. *cinereum* in Jamaica - Style base ring-like with thickened cells, x 230; Yuncker 17890 (S).
- Fig. 2 E: *C. cinereum* var. *ugandense* - Corolla lobe tip with T-shaped trichome and capitate glands, x 230 (S);
- F: Ovary wall crystals and idioblasts on cypselas, x 230; Taylor 2464 (S).
- G: *C. cinereum* var. *cinereum* in Australia - Filament collar elongate, narrow and cylindrical, x 230;
- H: Anther apical appendage ovate in shape, endothecial tissue intermediate, x 230; Eriksson 402 (S).
- Fig. 3 I: *C. cinereum* var. *cinereum* in the Philippines - Anther apical appendage ovate and tapering towards the apex, x 230; Ramos & Edano 43993 (S);
- J: *C. cinereum* var. *viale* in Madagascar - Anther apical appendage lanceolate-ovate with obtuse tip, x 80; Perrier de la Bathie 597 (S).
- K: *C. cinereum* var. *ovatum* in Madagascar - Anther apical appendage ovate with truncate tip slightly notched in the middle, x 230; Thunberg s.n. (S).

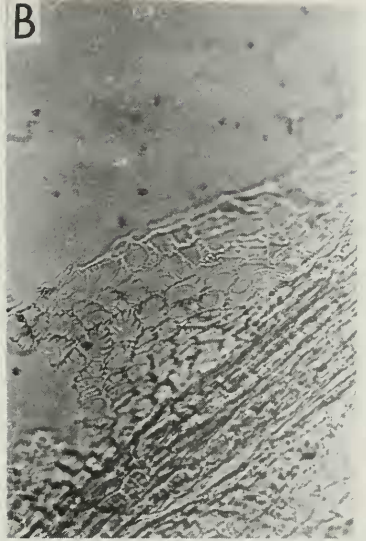
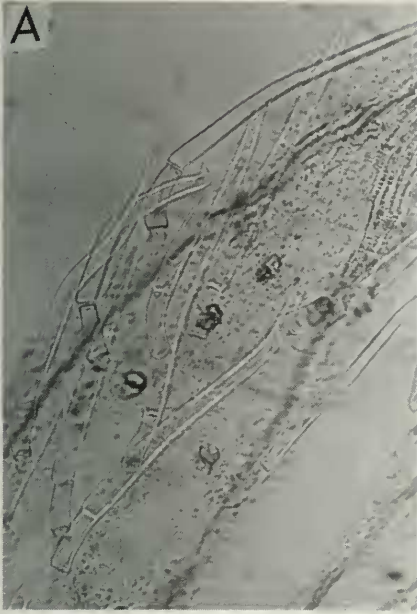


Fig. 1 A — D

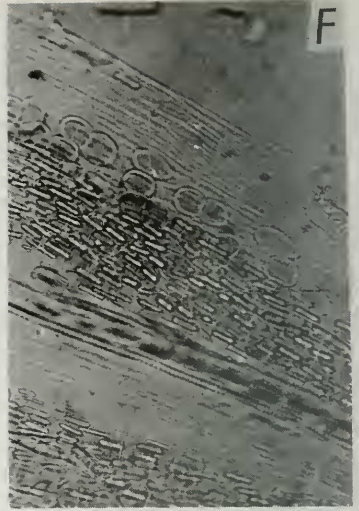


Fig. 2 E—H



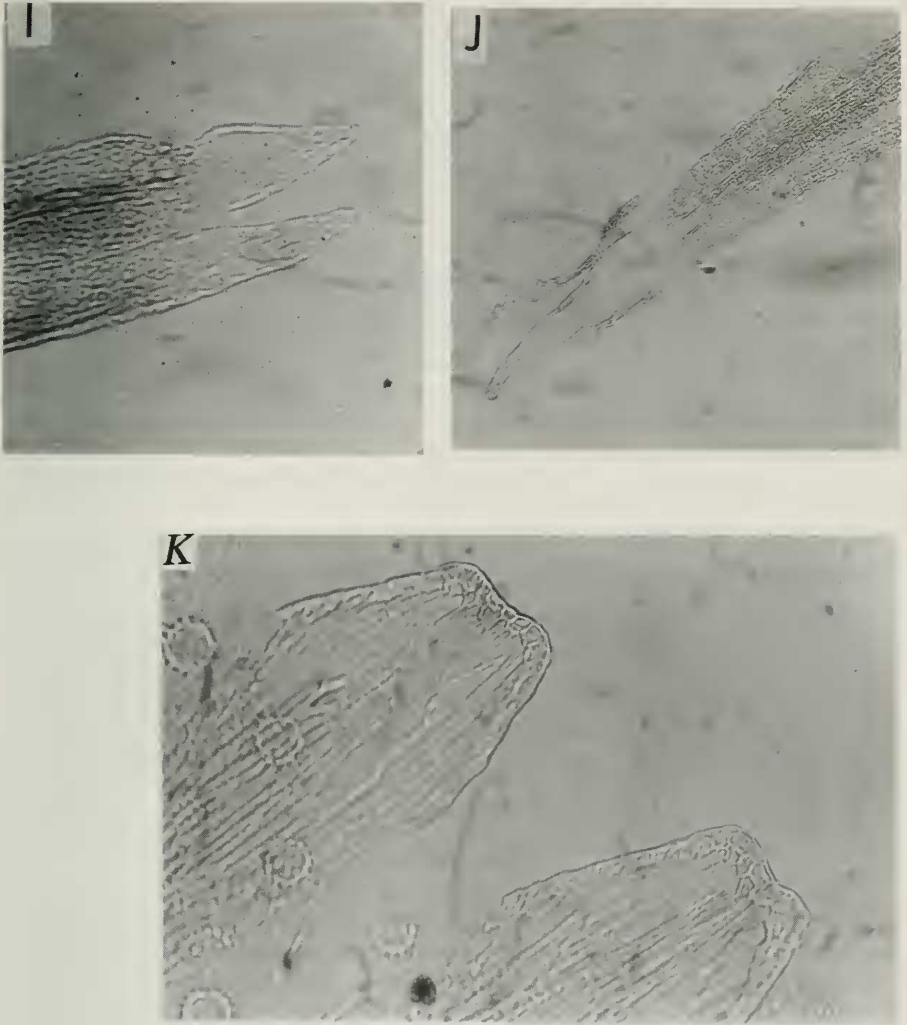


Fig. 3 I — K